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Forest Insect And Disease Management

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BIOLOGICAL

EVALUATION R10-82-2

SPRUCE BEETLE

ANCHOR POINT, ALASKA

JULY 1982

U.S. Department of Agriculture
State and Private Forestry

Forest Service
Alaska Region

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INTRODUCTION

Alaskan spruce beetle (Dendroctonus rufipennis (Kirby) (App.A) infestations decreased throughout Alaska in 1981. Approximately 233,519 acres of infested spruce were aerially detected. The majority of the infested spruce was white spruce (Picea glauca (Moench) Voss.) although sizeable amounts of infested Sitka spruce (P. sitchensis (Bong.) Carr.) and Lutz spruce (P. X lutzii Little) were noted.

White, Sitka and Lutz spruce mortality is occurring on approximately 40,000 acres of the Chugach National Forest, especially on the Kenai Peninsula. Beetle infestations on the rest of the Kenai Peninsula have decreased over 1980 levels with the exception of the Anchor Point area where there are 2,500 acres of scattered infestations (Fig. 1).

If spruce beetle outbreaks are allowed to run their natural cycles significant changes in stocking levels and aesthetic qualities of the landscape can occur.

Forest Pest Management (F.P.M.) was requested in late fall of 1981 by the State of Alaska, Department of Natural Resources, Division of Forestry to undertake a spruce beetle evaluation of the affected Anchor Point stands.

OBJECTIVES

(1) To determine and evaluate the incidence of bark beetle activity in the infested Anchor Point area.

(2) To discuss and recommend various management alternatives with respect to the infestations.

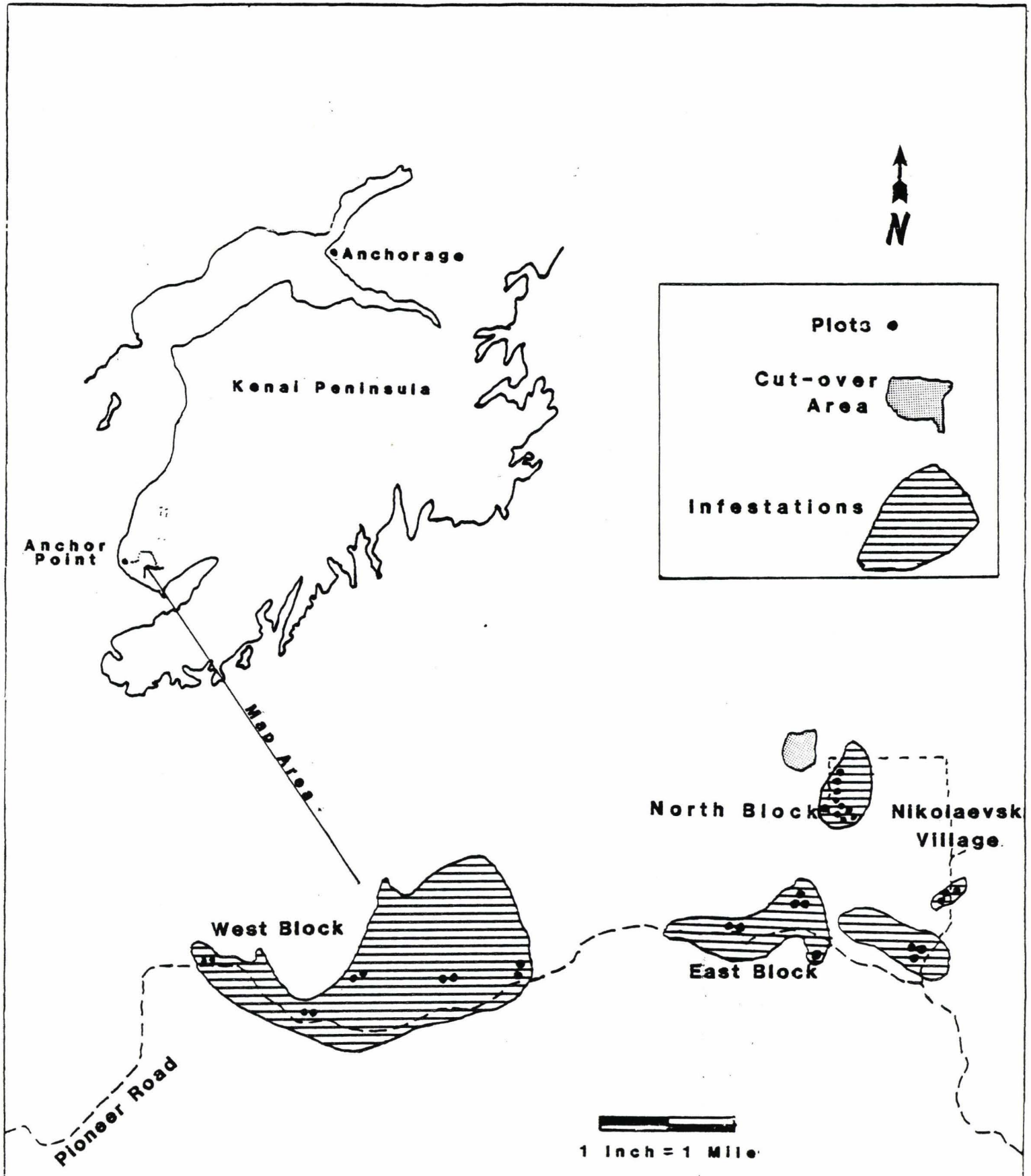

Fig. 1. Location of ground plots and on-going spruce beetle infestations in the evaluated areas.

MATERIALS AND METHODS

F.P.M. personnel undertake yearly insect and disease aerial detection surveys of the forested areas throughout the State. In early August the Anchor Point area was surveyed and current beetle activity was mapped on a 1:250,000 quadrangle.[1] Ground surveys were conducted in mid-April (1982) by F.P.M. personnel.

Sampling sites:

The aerial detection survey indicated that infestation levels were not uniform throughout the Anchor Point area. Beetle activity appeared to be more intensive in the eastern portions near Nikolaevak Village. Thus, the Anchor Point infestation was divided into three areas for sampling purposes: the West, East, aand North Blocks (Fig. 1).

Stand composition:

Variable-radius (prism) plots were used to determine stand composition in each sampling block. 10,10 and 12 variable plots were placed in the North, West, and East blocks, respectively. Plots were located at 1/2 mile intervals along the road system in the infested areas. At each location, two variable plots were established five chains apart. A basal area 10-factor prism and a Spiegal Relaskop were used to determine plot trees and tree heights. All trees within each plot were recorded by species and diameter at breast height (DBH). Radial growth and height were determined for two dominant or co-dominant spruce trees in each plot.

Spruce Beetle Activity:

Within each plot, spruce were noted as being attacked either in 1981, 1980, before 1980, or unattacked. The presence of pitch-outs (unsuccessful attacks) was also noted. Signs of woodpecker activity on spruce was visually categorized as either less than or greater than 50% of the first 20' of tree bole. Sampling of adult beetles is not feasible in the winter months and thus was not undertaken.

RESULTS AND DISCUSSION[2]

Bark beetle evaluations are normally undertaken from mid-July to mid-August. Bark beetle adults are accessible and easily sampled at this time. However, during the winter months, adult beetles overwinter in groups under the bark beneath the snow making sampling quite difficult. Winter evaluations would then rely only on stand data such as composition, structure, and attack levels.

1/ Data on file with Forest Pest Management, State and Private Forestry, USDA Forest Service, Anchorage, Alaska 99504
2/ See Appendices A and B for Summary

Stand Composition:

All sampling areas were comprised of Sitka and Lutz spruce (95%) with some scattered paper birch (5%) (Betula papyrifera Marsh) (Table 1). Pockets of old and new blowdown occur throughout the sampling areas and along many old seismic lines and new road construction. Directly to the west, northwest of the North sampled area is a tract of cut-over land (Fig.1). Large, old log decks are scattered throughout the area. Mean spruce diameter is similar for all three areas, averaging 11" dbh. Mean spruce height and age are similar for the three areas averaging 60-70' and 135 years, respectively.

Mean spruce basal area is 122, 153 and 185 square feet per acre for the West, East and North Blocks, respectively. Total mean basal area is similar as the plots were almost totally comprised of spruce. Spruce diameter growth for the three sampling areas is .08 inches per year in the last inch of growth. Mean spruce volume (live and dead trees) is 10,378, 8,800 and 13,130 b.f. per acre for the West, East and North Blocks, respectively.[3]

Spruce Beetle Activity and Tree Mortality:

Beetle activity in the three sampled areas has declined over the past few years (Table 2 and 3). As of 1981, 34%, 20% and 13% of the commercial spruce has been attacked or killed in the North, East, and West Blocks, respectively. The heaviest beetle activity has been in the North Block; an area having a high basal area and substantial amounts of brood material. Assuming a $35/MBF stumpage value[4], $41.55/ac., $81.73/ac. and $149/ac. of commercial spruce has been killed or is being attacked by spruce beetles in the West, East and North Blocks, respectiviely.

The infestations in the West Block have caused little impact with respect to spruce stocking and volume. Eighty-six % of the commercial spruce is presently unattacked. The infestation intensity is low and appears to be static to declining: % of commercial spruce killed in 1981, 1980 and pre-1980 are 4% (n=4), 5% (n=5) and 3% (n=3), respectively. Almost every attacked or beetle killed spruce has been heavily woodpeckered from the soil surface to a 20' trunk height. This heavy woodpecker predation undoubtedly has helped reduced beetle populations. There is little indication (based on the ten plots.) that beetle populations will increase in the West Block.

3/ Volume estimates derived form: (1) R-10 Volume Tables, Forest Service Handbook. 2425, Jan. 1967 in conjunction with (2) Table 1-Stand Factors - from "Log Scaling and Timber Cruising", 1966. J.R. Dilworth O.S.U. Bookstore. Page 263.

4/ Wade Wahrenbrock. 1982. Forester, State of Alaska, D.N.R. Soldotna, Alaska.

TABLE 1

STAND STRUCTURE

	STAND COMPOSITION(%) SPRUCE	BIRCH	SPRUCE DBH(in)	SPRUCE HT(ft)	SPRUCE AGE(yr)	AV.DIA GROWTH in./yr	SPRUCE B.A. sqft/ac	SPRUCE VOLUME b.f./ac
WEST BLOCK	95(116)*	5 (6)	11.3	70.9(14)	140(7)	.08	122(10)	10,378
EAST BLOCK	95(176)	5 (10)	11.3	62.7(17)	134(10)	.09	153(12)	8,800
NORTH BLOCK	95(185)	5 (10)	11.1	69.7(20)	127(20)	.09	185(10)	13,130

* Numbers in ( ) indicate sample size

TABLE 2

SPRUCE BEETLE POPULATION AND TREE MORTALITY

	Beetle Population			AV. D.B.H. 1981 attacks (in.)	AV. D.B.H. 1980 attacks (in.)	AV. D.B.H. pre-1980 att. (in.)	AV. D.B.H. uninf. spruce (in.)	Vol. lost in beetle kill(bf/ac.)
	Incr.	Static	Decr.					
WEST BLOCK	--	X	--	11.8(4)*	11.9(5)	14.9(3)	11.3(92)	1,187
EAST BLOCK	--	--	X	18.0(2)	15.2(5)	13.9(18)	10.8(132)	2,335
NORTH BLOCK	--	--	X	13.3(6)	11.8(12)	13.0(26)	10.5(127)	4,274

* Numbers in ( ) indicate number of trees

TABLE 3

Number of trees killed on sampling plots in the Anchor Point area and the year of mortality as determined by brood development of bark bettles in dead spruce sampled in April, 1982.

	Year of Attack		
	1981[1]	1980[2]	Pre-1980[3]
North Block	6 (5%)[4]	12 (9%)	26 (20%)
East Block	2 (2%)	5 (4%)	18 (14%)
West Block	4 (4%)	5 (5%)	3 (3%)
Total	12(11%)	22(18%)	47(37%)

[1]Trees with larvae present

[2]Trees with adults only

[3]Beetle-killed trees where brood adults have left

[4]Percent of commercial spruce

Similar to the infestations in the West Block, the East Block area has sustained little beetle impact with respect to spruce stocking and volume. Eighty-one % of the commercial spruce is presently unattacked. The infestations appear to be declining and are of low intensity. Pre-1980 attacks for 14% of the commercial spruce. This dropped to 5% in 1980 and to 4% in 1981. Similar to the West Block, woodpecker predation in the East Block was extremely high on attacked trees and has probably helped check or reduce beetle poopulations.

Similar to the West and East Blocks, the North Block infestations appear to be declining. Pre - 1980 attacks accounted for 20% of the commercial spruce. This dropped to 9% in 1980 and 5% in 1981. Sixty-five % of the commercial spruce is presently unattacked. Woodpecker predation was high on the attacked trees.

West-East-North Block Comparison:

The sampling sites are similar in stand compostiion and structure although spruce basal area is much higher in the North Block. Beetle intensity in all areas is quite similar in 1981 and 1980. However, there is a substantially higher amount of pre-1980 kill in the North and East Blocks than the West.

Bark beetle infested areas in the study sites appear to be declining. This is not due to a reduction in food supply since large numbers of susceptible diameter spruce remain in the areas. There is no significant difference between the diameters of trees attacked and killed in 1981, 1980 or pre-1980. Apparently the beetle populations are now low and appear to be kept in check, in part, by high woodpecker predation. The effect of abiotic factors such as winter temperatures and snow fall could have possibly contributed to the apparent beetle decline. However, there are no weather records for the infested area to substantiate this. Likewise a lower than average snowfall in the area would increase the effect of woodpecker predation by increasing the amount of tree trunk surface area available as woodpecker feeding sites.

As previously mentioned, there has been more (pre-1980) beetle kill in the North and East vs. the West Block (20% & 14% vs. 3%). Both the North and East Blocks have higher basal areas than the West Block. These more heavily stocked stands could have reduced tree vigor due to growing competition, resulting in increased susceptibility to beetles. Also, there has been more logging activity in the vicinity of the North and East Blocks. There are many old landing areas and scattered old log decks comprised of commercial size spruce. Such areas are attractive to beetles as breeding sites and may have been responsible for the original build up of beetles (See App.A).

Continued small spots of beetle activity can be expected throughout the sampling sites. As more of the surrounding land is developed, additional potential spruce beetle breeding material will appear. Trees scarred and weakened due to road, right-of-way, and home construction will contribute to this potential breeding material.

MANAGEMENT ALTERNATIVES

The following alternatives are applicable to spruce beetle infestations. However, the selection of one or more alternatives is the responsibility of the land manager-owner and can be based on a variety of reasons from aesthetic to purely economic considerations.

Maintain Present Management:

The spruce beetle infestations would be allowed to run their course under this approach. If left alone, spruce beetle infestations would collapse from a combination of: (1) lack of large diameter trees to maintain brood production; (2) unfavorable weather conditions, especially during adult Spring dispersal; and (3) heavy predation and parasitism. However, adverse as well as beneficial effects of the outbreak would have to be accepted, such as:

(1) Changes in forest plant composition could occur as a result of the opening of the forest canopy. Such changes may result in reduced spruce regeneration if no site disturbances occur and reforestation may be necessary. However, some of the plant composition changes may be beneficial to some wildlife.

(2) Following spruce beetle infestations, fire risk may increase. There will be an increase in rate of spread, ignition probability and burning index.

(3) Visual qualities and social impacts would result if this alternative was selected (Averill et. as 1977). The ratio of green spruce to "red topped" spruce to gray snags will decrease if spruce beetle populations continue to increase. In addition, the dead trees may constitute a safety hazard.

(4) There will be no direct costs associated with selection of this alternative although as previously mentioned, timber values will be affected and revenues reduced when severely damaged stands are harvested. Likewise, this alternative would not be effective in preventing additional tree mortality.

Chemical Suppression:

The use of registered pesticides for spruce beetle prevention and suppression is a viable alternative in certain situations:

(1) On a large scale, use of pesticides is not economically practical since individual trees must be treated using ground sprayers.

(2) In recreation areas and around homes where tree mortality would be unacceptable and hazardous to people, individual high value trees could be treated with an EPA-registered insecticide. Application costs would have to be accepted. Adverse environmental effects would be minimal and temporary.

A registered insecticide for use against the spruce beetle is Lindane[R]. Lindane is a Restricted Use Pesticide and can only be applied and used by a State certified applicator.

Trap Trees:

This alternative involves the falling of green uninfested trees to serve as an attractant to flying adults. Trees must be felled before beetle flight. Normally, one trap tree is felled for every four or five infested standing trees. Removal of infested felled trees is necessary within one year of infestation. If they are not removed, beetle populations may dramatically increase in the already infested area.

This method has been used successfully on the Chugach National Forest in campgrounds and is a viable alternative.

Salvage Logging:

Logging of infested material would remove the material to another location where the brood could be destroyed.

Effects of this alternative are:

(1) The lumber from the infested trees could be utilized (e.g. firewood).

(2) However, the removal of the infested trees may only be a temporary solution. Stand composition would not be altered to any degree through salvage logging alone and risk of future infestations could remain high.

Felling and Burning of the Infested Trees:

Falling and burning infested trees will destroy bark beetle brood. This should be done in winter to reduce the fire hazard and kill the beetles before spring emergence.

Effects of this alternative are:

(1) Lumber from the infested trees is not utilized.

(2) This alternative may not prevent future infestations occurring in the treated area.

Silvicultural Management:

Silvicultural treatments in spruce stands should be designed to create stand conditions that minimize tree mortality. Thinning of the residual stand and removal of the currently infested trees eliminates the immediate threat, as well as possibly creating a "beetle proof" stand for the next 20 or more years. This method appears to work with other Dendroctonus beetles and should work with spruce beetles (Averill 1978).

Effects of this alternative are:

(1) Conversion of spruce stands to a less susceptible state could be costly; however, long term benefits could be achieved. A sale for the removal of infested material as well as thinning could be let, thereby lowering the cost of this alternative.

(2) Hard (1982) recommends thinning of white spruce stands on the Kenai Peninsula to a range of spruce basal areas from 50 to 100 square feet per acre. These recommendations should be applicable to Sitka and Lutz spruce stands as well. Thinning improves tree growth in terms of diameter, volume and height through reduced competition. Stands with healthy, vigorous-growing trees are more resistant to losses by the spruce beetle than slow-growing or stagnant stands.

(3) This alternative would maximize investment returns since other management alternatives do not treat the mid-range (5-20 year) risk (Averill 1978).

(4) Application of sound silvicultural treatments could enhance other management objectives identified by the land manager.

RECOMMENDATIONS:

Based on the results of this evaluation, Forest Pest Management recommends that an additional aerial survey be carried out in August of 1982. At this time, all past and current infestations should be mapped on aerial photographs. This will facilitate locating and evaluating more of the infested areas. Before any decisions are made by affected land managers/owners concerning large scale management alternatives, a more intensive evaluation should be undertaken during late summer or early fall of 1982. However, if the land manager/owner desires to reduce beetle problems, the following alternations are recommended:

(1) Sanitation-Salvage:

Remove old beetle killed timber as well as currently infested material. This will reduce the immediate beetle population somewhat as well as utilize the infested material (house logs, firewood, etc.). Do not allow blowdown of large diameter trees to accumulate since bark beetles prefer to breed in fresh blowdown. Prompt utilization (within 1-2 years) of blowdown for firewood, etc. will eliminate this breeding material. Blowdown which has been on the ground for more than two years is not a threat.

(2) Maintain Tree Vigor:

Reduce those actions which can decrease tree vigor and thus increase its susceptibility to bark beetles. Such actions are: scarring tree trunks, soil compaction around root zone, severing tree roots, etc..

(3) Chemical Suppression:

As previously mentioned, Lindane is registered for the prevention and control of spruce bark beetles. However, it must be applied by a certified applicator as it is a Restricted Use Pesticide. The economics of this measure should be carefully analyzed.

REFERENCES

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Hard, J.S. 1982. Stand and Tree Variables Associated with Spruce Beetle Attacks in a Kenai Peninsula Infestation: Implications for Management. In:Proceedings of the Second Alaska Integrated Pest Management Conference: pgs.72-81 (in press).

APPENDIX A

SPRUCE BEETLE

COLEOPTERA:SCOLYTIDAE

Dendroctonus rufipennis (Kirby.)

HOST--White, Sitka, and rarely black spruce

DAMAGE--Larvae feed under tree bark which may result in tree death

DISTRIBUTION--Throughout Alaska where host is located. A serious forest pest especially in south-central Alaska.

DESCRIPTION--Adult spruce beetles are dark brown to black, cylindrical in shape, approximately 5mm long and 3mm wide. The larvae are stout, white, legless grubs, 6mm long at maturity. The pupae are white, soft-bodied, and adult shaped.

BIOLOGY--The life cycle of the spruce beetle in Alaska is not definitely known, but is believed to be two years in duration. Adult and larval activity begins in May when under the bark daytime temperatures reach about 8°C(47°F). Recently emerged adult beetles disperse in search of susceptible host material during late May and early June when daytime ambient temperatures are at least 16°C(61°F). Dispersing adults adults can fly long distances, over seven miles nonstop. Adult mortality during dispersal may exceed 50 percent. Females are attracted to windthrow and other large diameter (8" or more) down material and begin the attack; males arrive later.

Beetles prefer to begin attack on the sides and bottoms of downed material. Under such conditions, temperature and moisture regimes are favorable for brood development and survival. Unpublished data indicate that windthrown trees can remain attractive through two attack periods. Males and other females are attracted via sex and aggregating pheromones. *D. rufipennis* is monogamous, and females deposit eggs in niches along the sides of the vertical egg gallery in a standing tree. Egg galleries, except for the terminal portion, are packed with frass and boring material. Most eggs hatch by August.

Larvae predominate during the first overwintering period, although other life stages may be present. Most of the larvae pupate in the following summer; the pupal period last 10-15 days. The adults may overwinter in their pupal sites or migrate to the base of infested trees. This migration is an adjustment to cold temperature survival. The following spring (approximately two years after attack) adults emerge and attack new host material. In general, females only attack once.

Most *D. rufipennis* outbreaks in standing timber have originated in blowdowns although logging residuals (cull logs) may be a contributing factor. In the Rocky Mountains and probably Alaska, the susceptibility of standing spruce decreases in the following order: (1)Large diameter trees along creek bottoms, (2)Better stands on benches, (3)Poorer stands on ridges and benches, (4)Mixtures of spruce and other species, and (5)Stands of immature trees.

In the lower 48 states, parasites and predators help reduce and maintain spruce beetle populations at low levels. However, the effect of predation and parasitism on spruce beetle populations in Alaska is not known. In the Rocky Mountains, Northern 3-toed, hairy, and downy woodpeckers can consume 40-98 percent of beetle brood during outbreak conditions. These predators are common in Alaska in beetle infested areas and probably contribute to the decline of epidemic insect populations. Low temperatures are effective controls if the cold spells occur early before the insects become cold hardy.